An improved flame atmosphere analyzer and a water-heating device including the analyzer

DESCRIPTION

The present invention relates to a flame atmosphere analyzer according to the preamble to the main claim.

The invention also relates to a water-heating device including the analyzer.

The invention concerns, in particular but not exclusively, the field of flame atmosphere analyzers used for piloting the lighting of gas burners provided in storage water heaters for heating water for hygiene purposes.

These analyzers are preferred to other known devices because of the safety functions which typically characterize them. They are in fact used not only for lighting the main burner and for stopping the gas supply to the burner when the flame goes out and/or when the pressure falls below a safety threshold, but also for intervening to cut off the gas supply when the oxygen content of the combustion air falls below a safety value or, conversely, when the carbon-dioxide content rises. To ensure this greater sensitivity, these atmosphere analyzers have dimensions suitable for the use of air-gas mixing ratios such as to give rise to a fairly unstable flame which is susceptible to detachment upon variations in the oxygen content of the air.

In the specific field of storage water heaters for heating water for hygiene purposes, it is known to use these devices in areas such as, for example, garages, which are intended for the parking of motor vehicles and/or for the storage of inflammable materials such as oils, solvents, paints and similar substances. In these cases, liquids or vapours due to leakages of these substances from the storage containers or to leakages of fuel from the motor vehicles may be set on fire by the flame which is present in the burner of the water heater, with dangerous consequences.

To solve this problem at least partially, the prior art has proposed the introduction of special flame-arresting grids in the openings for admitting air to the combustion chambers of water heaters. These grids have very fine mesh configurations which confine the flame within the combustion chamber, preventing it from spreading outside the water heater and consequently being propagated in the surrounding environment.

The main limitation encountered in this proposed solution is due to the fact that dust, hair, and other "dirt" which is normally present in such environments may obstruct these flame-arresting grids, resulting in a worsening of the combustion characteristics, for example, owing to a high level of carbon monoxide (CO) production, and the occurrence of possible functional problems in the water heater, which are connected, for example, with the production of soot, with partial obstruction of the ducts for evacuating discharge fumes, or with possible flare-ups. Naturally, all of this may lead to conditions dangerous to people who are in the vicinity of the environment surrounding the water heater.

The problem underlying the present invention is that of providing a flame atmosphere analyzer, as well as a water-heating device including the analyzer, which have structural and functional characteristics such as to overcome the limitations encountered with reference to the prior art mentioned.

This problem is solved by the invention by means of a flame atmosphere analyzer and a water-heating device including the analyzer which are formed in accordance with the appended claims.

The characteristics and the advantages of the invention will become clearer from the following description of a preferred embodiment thereof, described by way of non-limiting example, with reference to the appended drawings, in which:

- Figure 1 is a schematic front elevational view of a flame atmosphere analyzer formed in accordance with the present invention,
- Figure 2 is an axial section through a detail of the analyzer of Figure 1,
- Figure 3 is a partial perspective view of a detail of a water-heating device incorporating the analyzer of the preceding drawings,
- Figure 4 is a side elevational view of the detail of Figure 3, and
- Figure 5 is a partial axial section of the water-heating device of Figures 3 and 4.

With reference to the drawings mentioned, a flame atmosphere analyzer formed in accordance with the present invention is generally indicated 1 and is designed, in particular but not exclusively, for use in a device for heating water for hygiene purposes, for example, a storage water heater 2, shown schematically in Figure 5.

The water heater 2 comprises a tank 3, part of which is intended to hold water, and in the bottom of which a combustion chamber 4 is defined, connected to a flue 5 for the discharge of the combustion fumes. A main burner 6 disposed in the chamber 4 is supplied with gas delivered through a valve unit 7 provided in a supply line 8. An auxiliary gas line 9 is also provided for supplying gas to the analyzer 1 through the valve unit 7.

The analyzer 1 comprises a support 10 to which a tube 11, a thermocouple flame-detection device 12, and a flame-igniter plug 13 are fixed.

The tube 11 has a polygonal shape and is hollow internally. A fuel-gas supply nozzle 14 is screwed to one of its ends. A burner 15, fitted on the opposite axial end of the tube, is formed by the coupling of two superimposed plates shaped so as to define a tubular duct 16 and a bent end portion 17 in the region of which the tubular duct 16 branches into a first flame jet and a second flame jet, indicated 18 and 19, respectively. The flame jets 18, 19 diverge substantially at right angles and are connected by a thin flattened duct 20 so as to provide continuity of flame between them.

Ignition of the analyzer 1 is triggered by an electric arc which is established between an electrode 13a of the plug 13 and the burner 15 when a potential difference is generated between them, for example, by conventional piezoelectric devices. The electric arc brings about ignition of the air/fuel-gas mixture which emerges through the flame jet 18 and the flame thus ignited is propagated through the flattened duct 20 to the flame jet 19.

The tube 11 comprises an intake and mixing chamber 21 coaxial and in flow communication, at one end, with the tubular duct 16 and, at the other end, with the nozzle 14. The side wall of the tube 11 has a threaded through-hole 22 (or more than one threaded through-hole) which is intended, in accordance with a principal characteristic of the invention, to put the mixing chamber into flow communication with an end 24a of a duct 24. The duct 24, which is of tubular shape, is open at its opposite end 24b so as to take in primary combustion air for the burner 15 in a position remote and at a predetermined distance from the corresponding inlet hole 22 formed in the side wall of the intake and mixing chamber 21. By virtue of the duct 24, the intake point of the primary combustion air is thus removed from the tube 11 of the analyzer, at a predetermined distance

and position the determination of which will become clear from the following description.

The thermocouple flame sensor 12 and the electrode 13a of the igniter plug 13 are electrically connected, by means of respective conductors 25, 26, to a driver circuit 27 incorporated in the valve unit 7, and can control a solenoid valve, not shown, for supplying the gas to the main burner 6, with the operative functions described in detail below.

In the combustion chamber 4 of the water heater 2, there are also air-inlet means including an opening 28 covered by a flame-arresting grid 29 having a mesh of a size and closeness such as to ensure that the combustion flame of the burner 6 is contained within the combustion chamber 4, even when inflammable vapours and/or liquids from the external environment surrounding the water heater 2 are set on fire by the flame.

The flame-arresting grid 29 is located below the main burner 6 in a lower portion of the combustion chamber 4, opposite the fume-discharge flue 5. The duct 24 for taking in the primary combustion air preferably opens in this lower portion of the chamber 4, in the vicinity of the main burner 6.

The duct 24 also opens close to the flame-arresting grid 29 and preferably has a first portion 24c extending from the intake chamber 21 and a second portion 24d forming an extension of the first portion and bent substantially at right angles thereto.

In operation, the duct 24 thus serves to take in and to monitor the primary combustion air in a preselected position in the combustion chamber. When the oxygen content falls below a predetermined minimum value constituting a danger threshold, the amount of oxygen supplied with the primary combustion air is insufficient to keep the flame adhering in a stable manner to the jets 18, 19. In this case, the lack of oxygen is compensated for by the secondary combustion air available at the mouth of the burner 15 and the flame therefore becomes detached from the burner, bringing about cooling of the hot junction of the thermocouple flame sensor 12 and hence stoppage of the fuel-gas supply, for example, by closure of a conventional magnetic unit associated with the solenoid valve of the valve unit 7. This reduced oxygen-content condition may occur if the flame-arresting grid 29 is partially obstructed or blocked, for example, owing to

the deposition of dust or other dirt on the mesh of the grid. This causes a worsening of the combustion characteristics, for example, the production of carbon monoxide (CO), which can poison the surrounding environment, with the possibility of flaring-up or the production of soot tending to obstruct the passageway for the discharge of the fumes into the flue. In both situations, tests carried out by the Applicant have shown that monitoring of the primary combustion air in a predetermined position remote from the analyzer tube enables the analyzer to make the system safe by cutting off the gas-flow to the burner before the above-mentioned dangerous conditions resulting from even partial obstruction of the flame-containment grid arise. In particular, the positioning of the intake point of the primary combustion air as indicated in the foregoing description has given improved results in terms of the immediate response of the system when dangerous conditions arise as a result of obstruction of the flame-containment grid, with activation of the magnetic closure unit brought about by the thermocouple which is sensitive to detachment of the flame in the burner.

The water heater is therefore locked out before dangerous conditions due to the obstruction of the flame-arresting grid can arise, by bringing about safety intervention of the analyzer so as to force the user to clean the grid in order to be able to re-light the water heater.

The invention thus solves the problem posed, achieving the advantages indicated above over known solutions.